Association for Information Systems
AIS Electronic Library (AISeL)

AMCIS 2001 Proceedings

Americas Conference on Information Systems (AMCIS)

December 2001

Investigation of Lagged Impacts of Information Technology Expenditures in a Public Accounting Firm

Rajiv Banker
University of Texas at Dallas

Hsihui Chang
University of Texas at Dallas

Yi-Ching Kao
University of Texas at Dallas

INVESTIGATION OF LAGGED IMPACTS OF INFORMATION TECHNOLOGY EXPENDITURES IN A PUBLIC ACCOUNTING FIRM

Rajiv D. Banker
University of Texas at Dallas
rbanker@utdallas.edu

Hsihui Chang
University of Texas at Dallas
swchang@utdallas.edu

Yi-ching Kao
University of Texas at Dallas
yiching@utdallas.edu

Introduction

Recent empirical research has documented positive impacts of information technology (IT) investments (Brynjolfsson 1993). However, most IT productivity studies have relied largely on cross-sectional evidence. In this paper, we study IT productivity impacts using time series data for 36 months from one of the Big Five public accounting firm in Taiwan. We examine the IT impacts not only at the time when the investments are made but also in the subsequent periods. This longitudinal study allows us to evaluate causality as well as investigate the potential lagged impacts of IT. Moreover, it enables analysis of the longitudinal pattern of IT productivity impacts to assess the organizational learning and adjustment costs for IT adoption before productivity improvement is manifest.

While IT productivity has been studied in several industries, our study is perhaps the first focused on the professional services industry in which information and knowledge work play a prominent role. The public accounting profession has been changing rapidly in recent years to leverage information technology in its audit and taxation services (Elliot 2000). Therefore, the estimation of the productivity impacts of IT expenditures in a public accounting firm is of considerable interest to both academia and practice.

We collected a panel of data over 36 months for 5 branches of the public accounting firm. Data from branches of a single firm helps control for unmeasured organizational and cultural factors that may influence productivity, although it also limits broad generalizations to other contexts. Access to senior management enabled us to obtain qualitative information to enrich the insights obtained from our quantitative analysis.

Research Questions

Literature Review

The inability of early research on IT productivity to document positive impact of IT on firm performance was referred to as the "IT productivity paradox". One of the explanations for the IT productivity paradox phenomenon is the lag in productivity gain because of organizational learning and adjustment (Brynjofsson 1993). Yet, very few empirical studies have addressed the lag problem. Devaraj and Kohli (2000) examined the impact of IT investment on hospital performance assuming a 3-month lag for IT labor and a 4-month lag for IT capital. Loveman (1994) used a distributed lag model to examine the pattern of lagged impacts of IT, but there were only 4 time points available in his data set.

In the operations management literature, there is empirical evidence (Hayes and Clark 1986, Chew et al. 1990, Banker et al. 2001) documenting a U-shaped curve for the longitudinal process for non-IT capital investments: plant productivity often decreases initially when investment in new equipment is made, but then increases over a longer period. This lag in the productivity impact of manufacturing investment reflects the time required by an organization to learn and adapt to the new technology. This research is to verify if IT has similar characteristics to other capital investment in its longitudinal impacts.

Production in a Public Accounting Firm

Professional staff is the primary and often the constraining input in the professional services industry. Therefore, our objective is to analyze the impacts of IT expenditure on the profitability per professional in a public accounting firm over time. While accounting professionals are the major driver for the firm's service output, the professionals need to incur some operating costs (such as office rent, travel) to support their work. The profitability per professional can be formulated as follows:

$$\text{Profit per professional} = \frac{\text{Revenue Output - Operating Cost - IT Expenditure - Professional Salaries}}{\text{Number of Professionals}}$$

$$= \begin{bmatrix}\text{Revenue}\\ \text{Generation}\\ \text{Productivity}\end{bmatrix} - \begin{bmatrix}\text{Operating}\\ \text{Cost}\\ \text{Intensity}\end{bmatrix} - \begin{bmatrix}\text{IT}\\ \text{Intensity}\end{bmatrix} - \begin{bmatrix}\text{Professional}\\ \text{Salary}\\ \text{Rate}\end{bmatrix}$$

In the context of public accounting services production, we will examine the relationship between IT intensity and revenue generation productivity as well as IT intensity and operating cost intensity. Since there is no significant correlation between IT intensity and professional salary rate, we can then infer the relationship between IT intensity and profit per professional.

Research Hypotheses

Prior research on IT investment impacts speculates that organizations require a certain period of time for learning and adjustment before productivity improvement may occur (Brynolfsson 1993, Soh and Markus 1995). Our field interviews with the professionals at our research site suggested that users require time to learn the new technology and find ways to use it for value creation. During such learning process, the professionals may slow down their regular work and thus their revenue generation productivity may decline. Consequently, we posit:

H1a: IT intensity initially has negative lagged impacts on revenue generation productivity.

After the initial learning process, the professionals are expected to realize the benefits from IT in reducing working hours per engagement. In addition, familiarity with new software may appeal to new clients and generate new engagements and higher fees. Hence, we conjecture:

H1b: IT intensity has positive lagged impacts on revenue generation productivity in the later lagged periods.

A similar learning curve pattern is expected for IT impacts on operating support costs. Initially, the professionals may incur more operating costs during the trial-and-error learning process. After that, the IT investment will result in a reduction in operating supporting costs by decreasing paper, copying, telephone, postage and travel expenses. Therefore, we posit the second set of research hypotheses as follows:

H2a: IT intensity initially has positive lagged impacts on operating cost intensity.

H2b: IT intensity has negative lagged impacts on operating cost intensity in the later lagged periods.

Combining the revenue side and the cost side impacts, we expect that IT spending has similar pattern of decreasing and increasing lagged impacts on the overall professional productivity at our research site:

H2a: IT intensity initially has negative lagged impacts on overall professional labor productivity.

H2b: IT intensity has positive lagged impacts on overall professional labor productivity in later lagged periods.

Empirical Analysis

Data Description

We collected data from the monthly accounting statements for each branch at our research site. The panel includes 36 monthly observations from January 1997 to December 1999 for each of 5 branches for the following variables:

- Branch's monthly IT expenditure – includes spending on IT hardware, software and labor.
- Branch's monthly revenue – from the branch monthly income statement.
- Branch's monthly operating cost – operating expense from the branch monthly income statement excluding professional salary and IT-related costs.
- Number of professionals in each branch every month

A challenge in this context is to measure the monetary value of branch monthly output. Due to the revenue collection method at our research site, the revenue reported in the monthly income statements does not equal the actual monthly output. For certain audit jobs continuing over several months, the branches do not accrue revenue on those jobs every month, rather they recognize revenue only in the month they bill the clients. The practice is to bill clients for the pending unbilled jobs twice each year. We label these two months as the "billing" months. Our discussions with senior management indicated that each branch has its own billing months depending on its mix of clients, but in all cases the billing months are six months apart. Assuming that a proportion ρ of the output is uncollected in each non-billing month, we formulate the relationship between the actual monthly output and revenue reported in the monthly income statement.

Estimation Model

We construct a system of two equations to test our research hypotheses. The first equation models the impacts of IT intensity on revenue generation productivity. The dependent variable in the first equation is the monthly actual output scaled by the number of professionals in the branch. Since the branch monthly actual output is not observable, it is replaced by an expression in terms of the revenue reported in the monthly income statement and the proportion ρ of uncollected output. The second equation models the impacts of IT intensity on operating cost intensity. The dependent variable in the second equation is the monthly operating cost scaled by the number of number of professionals in the branch. The two equations have the same explanatory variables including contemporaneous IT intensity (IT expenditure scaled by the number of professionals in the branch), lagged IT intensities, and four branch dummy variables. The dummy variables are to capture branch differences in a fixed effects specification (Greene 1997, pp. 615-618).

Estimation Results

We estimated our model with different numbers of lags, ranging from zero to eight, and found that including 6 lags is the most appropriate specification for our model based on the Akaike Information Criterion. According to the estimation results for the first equation, the lagged impacts of IT intensity on revenue generation productivity exhibit a U-shaped pattern as expected. The value of the coefficients of the lagged IT variables is close to zero (0.04) for the first-month lag, becomes negative (-1.58 and –2.22) for the second- and third-month lags, and turns positive (0.17, 3.18, and 3.43) for the forth-, fifth- and sixth-month lags. Among them, the coefficients of the second-, third-, fifth-, and sixth-month lags are significant at conventional levels. However, the estimation results for the second equation do not exhibit a U-shaped pattern for the lagged IT impacts on operating cost intensity. The values of the coefficients of the six lagged IT variables are all negative, between -0.01 and -0.25, and significant at conventional levels for the third- and fifth-month lags.

We also evaluated the aggregate impacts from IT over the first three and the next three lagged months (Greene 1997, pp. 783-784). On the revenue generation side, statistical tests indicated the existence of learning and adjustment costs in the first three lagged months and substantial productivity gains in the next three lagged months. Therefore, the research hypotheses H1a of negative initial lagged impacts and H1b of positive longer-term lagged impacts are confirmed. On the operating cost side, the research hypothesis H2a about positive initial lagged impact is not supported for the first three lagged months, but for the next three lagged months there are significant cost-saving benefits, supporting the research hypothesis H2b.

Employing the empirical estimates, we calculated the marginal impact of IT intensity on profit per professional. For the first three lagged months, a $1 increase in the IT expenditure per professional results in a decrease of more than $3 in the profit per professional and the impact is significantly different from zero. Therefore, our hypothesis H3a about the negative initial impact of IT on professional labor productivity is supported. For the next three lagged months, a $1 increase in the IT expenditure per professional results in a more than $5 increase in the profit per professional. This marginal impact is significantly different from zero and thus our hypothesis H3b regarding positive lagged impact of IT on professional labor productivity in the later lagged period is also supported.

Conclusion

This study is one of the first empirical examinations of IT productivity impacts in the professional services industry. At the methodological level, its contribution is the development of a novel estimation model to match the actual output and reported revenue of the firm and capture the special production structure in the professional service industry. At the substantive level, this study extends the IT productivity literature by providing a detailed longitudinal analysis of the lagged impacts of IT investment. Specifically, it reveals that there may be short-term pain due to organizational learning and adjustment before there are long-term gains. The implication for managers is that the evaluation of IT investment payoffs requires a longer term perspective rather than an emphasis on instantaneous improvements.

References

Banker, R.D., Field, J. and Sinha, K., "Work Team Implementation and Trajectories of Manufacturing Quality: A Longitudinal Field Study," *Manufacturing & Service Operations Management* (3:1), Winter 2001.

Brynjolfsson, E., "The Information Technology and the Productivity Paradox," *Communication of the ACM* (36:12), 1993, pp. 66-77.

Chew, W.B., Leonard-Barton D., and Bohn, R.E., "Beating Murphy's Law," *Sloan Management Review*, Spring 1991, pp. 5-16.

Devaraj, S., and Kohli, R., "Information Technology Payoff in the Health-Care Industry: A Longitudinal Study," *Journal of Management Information systems* (16:4), Spring 2000, pp. 41-67.

Elliott, R.K, "Who Are We As a Profession – And What Must We Become?" *Journal of Accountancy*, Feb. 2000, pp. 81-85.

Greene, W.H., *Econometric Analysis*, Third Edition, Prentice Hall, 1997.

Hayes, R.H. and Clark, K.B., "Why Some Factories are More Productive than Others," *Harvard Business Review*, Sep.-Oct. 1986, pp. 66-73.

Loveman, G.W., "An Assessment of the Productivity Impact of Information Technologies," in *Information Technology and the Corporation of the 1990s*, Edited by Allen, T.J. and Morton, M.S., Oxford University Press, 1994.

Soh, C., and Markus, M.L., "How IT Creates Business Value: A Process Theory Synthesis," *Proceedings of the 16th International Conference of Information Systems*, 1995, pp. 29-41